IBM

Reference Manual

7701 Magnetic Tape Transmission Terminal

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7701 Magnetic Tape Transmission Terminal

MINOR REVISION (July, 1961)

This edition, Form A22-6527-1, is a minor revision of the preceding edition but does not obsolete Form A22-6527. Principal changes in this edition are:

PAGE	SUBJECT
18	File protect light on during load-rewind operation
25-30	Extended instructions for input check indication at the transmitting terminal
28	Change in checking procedures if run light fails to come on during normal start at the receiving terminal.

Preface

With IBM 7701 Magnetic Tape Transmission Terminals, users of magnetic tape can transmit records from one location to another with the same ease with which they place a telephone call or communicate by telegraphic means.

An IBM TELE-PROCESSING* product, the 7701 incorporates a unique combination of engineering features including *incremental tape reading and writing, core code translation,* and extensive *checking* features. Coupled with the use of transistors, printed circuitry, and modular design, these features equip the 7701 to perform direct magnetic-tape data transmission with:

Incremental character-by-character operation: The 7701 transmits records of any length.

Accuracy: A complete checking system monitors reading, writing, and transmission, to insure accurate transfer of data.

Automatic retransmission: Manual intervention is minimized, since errors are corrected automatically by backspacing and retransmitting any record that causes an error.

Adaptability: The 7701 system may be used on either message service or private lines, at either 150 or 75 characters per second (depending on the information capacity of the line). Either binary or binary-coded-decimal tape, with a density of 200 characters per inch, may be transmitted and received.

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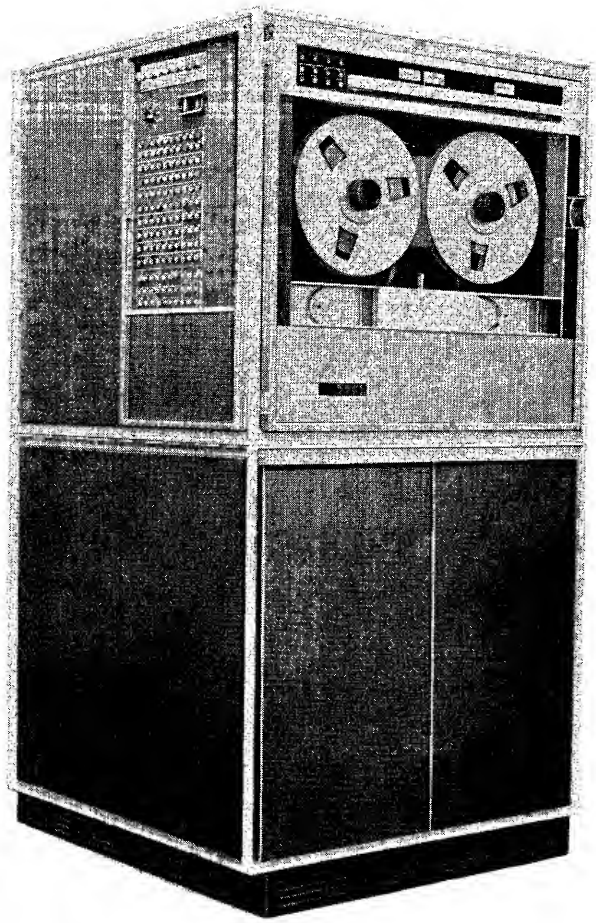
* Trademark.

Contents



IBM 7701 Magnetic Tape Transmission Terminal

Magnetic tape transmission offers the advantages of being direct and being timely. It promotes rapid updating and interrelating of different sections of any organization such as a railroad, utility, commodity brokerage or processor, security brokerage, insurance company, or government agency.

The IBM 7701 Magnetic Tape Transmission Terminals are designed primarily for operation on either the message service or the leased data-transmission channels now offered by communications companies. However, these 7701 terminals can use any equivalent transmission channel whose input-output connections conform to the specifications of the Electronics Industries Association's *Recommended Standards 232*.

The user of the 7701 must arrange with a common carrier (communications company) to furnish the data communication channel with modulation and demodulation equipment at each terminal. The 7701 is designed for use on transmission channels (wire or radio) with data information capacity equivalent to message service or private telephone lines (600 and 1200 bits per second). These speeds of 600 and 1,200 bits per second correspond to character transmission rates of 75 characters per second and 150 characters per second, respectively. The 7701 reads and writes tapes with a density of 200 characters per inch. Thus, it is able to use tapes from or prepare tapes for the IBM 7330, 727, 729 I, 729 II, and 729 IV Magnetic Tape Units.

The 7701 accepts tape records written as either binary code or binary-coded-decimal (BCD) data. It checks that the characters read into the transmitting terminal are valid, translates the input characters into the transmission code, transmits them to the remote terminal (checking that each received character is valid), translates back into BCD or binary code, and writes on an output tape. If the receiving terminal is in "write-read" mode, each written character is read at the read-write head and checked again for validity.

Data processing with the IBM 7701 offers the time-saving convenience of automatic retransmission of records when any type of error indication is present. If the error persists through one retransmission, a second automatic retransmission takes place before the terminal halts and alerts the operator. These automatic retransmissions occur regardless of whether the error occurs (1) during reading of the tape at the transmitting terminal, (2) during transmission, or (3) during recording of the characters onto tape at the receiving terminal. The last check can be eliminated, if desired, by setting a switch to disconnect the write-read feature.

Although using the write-read feature may lengthen transmission time, it guards against errors in writing caused by tape creases, dust particles, coating imperfections, or any other tape defect. Figure 1 is a graph comparing the effective transmission rate using write-only mode with the effective transmission rate using write-read mode (for differing record lengths). Note that the longer the record, the less the difference in effective character rates.

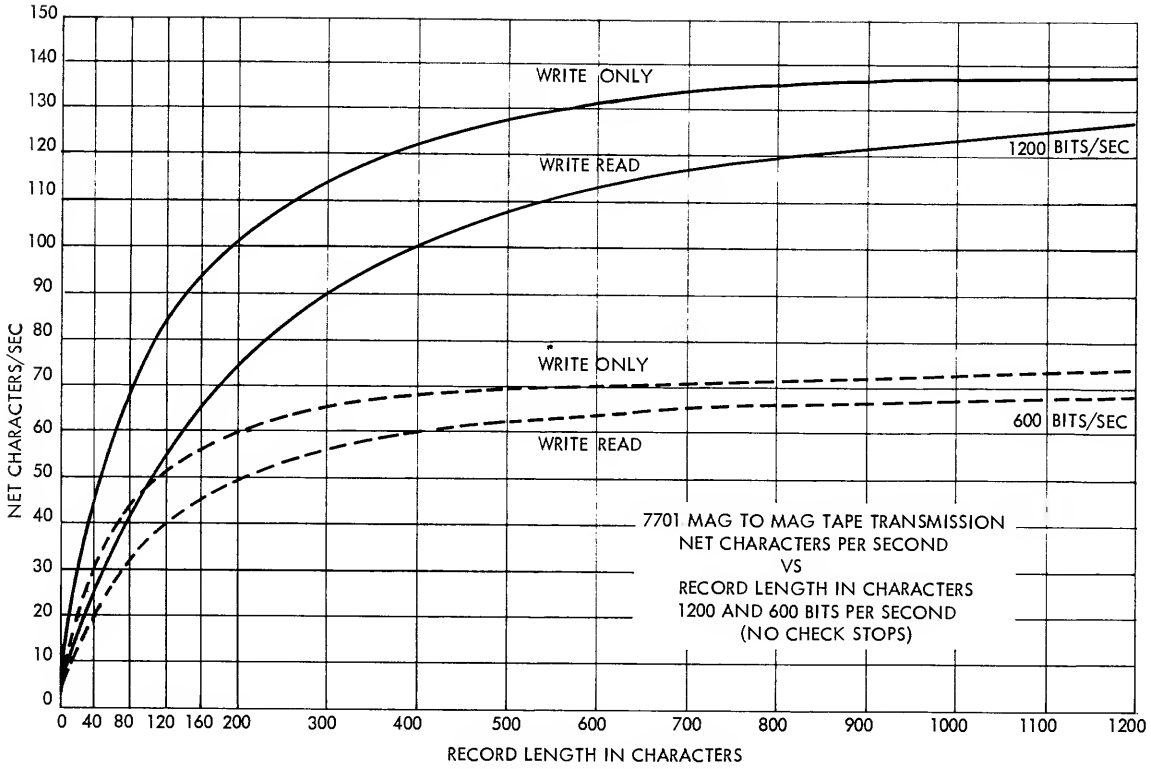


Figure 1. Transmission Rates for Write-Only Mode and Write-Read Mode

CHARACTER CODES	1	2	4	8	R	O	X	N
Space			×	×	×		×	
0			×		×	×		×
1	×						×	×	×
2		×					×	×	×
3	×	×				×			×
4				×			×	×	×
5	×			×		×			×
6		×	×			×			×
7	×	×	×			×			
8					×		×	×	×
9	×				×	×			×
A	×					×	×	×	
B		×				×	×	×	
C	×	×					×	×	
D				×		×	×	×	
E		×					×	×	
F			×	×			×	×	
G	×	×	×						×
H					×	×	×	×	
I	×				×		×	×	
J	×					×		×	×
K			×			×		×	×
L	×	×						×	×
M				×		×		×	×
N	×			×				×	×
O			×	×				×	×
P	×	×	×					×	
Q					×	×		×	×
R	×				×			×	×
S		×				×	×		×
T	×	×					×		×
U				×		×	×		×
V	×			×			×		×
W		×	×				×		×
X	×	×	×				×		
Y					×	×	×		×
Z	×				×		×		×
/	×					×	×		×

CHARACTER CODES	1	2	4	8	R	O	X	N
#	×	×		×	×			
.	×	×		×				×
$	×	×		×			×	
,	×	×		×		×		
@			×	×	×			×
¤			×	×		×	×	
*			×	×			×	×
%			×	×		×		×
&		×	×	×				×
–		×	×	×			×	
$\bar{0}$		×		×			×	×
$\overset{+}{0}$		×		×		×	×	
Record Mark		×		×		×		×
Group Mark	×		×	×				×
Delta	×		×	×			×	
Block Mark	×		×	×		×		
Tape Mark	×		×	×	×			
Word Separator		×		×	×		×	
		×	×	×	×			
(Unassigned codes used for binary magnetic tape transmission)		×	×		×	×		
			×	×	×	×		
		×		×	×	×		
	×	×	×	×				
		×	×		×		×	
			×	×	×		×	
					×	×	×	×
CONTROL CODES								
Idle	×			×	×	×		
Error/Inquiry	×			×	×		×	
Transmit Leader	×		×		×	×		
Control Leader (Test Pattern)	×		×		×		×	
SOR-1/ACK-1	×	×			×		×	
SOR-2/ACK-2	×	×			×	×		

Figure 2. Four-of-Eight Code for the 7701

The Magnetic Tape Transmission Terminal consists of two vertically-mounted standard modular system (SMS) cubes (frontispiece). The upper cube contains the tape transport, its control unit, a front panel for the operator's use, and a side panel for the joint use of the operator and the customer engineer. The lower cube contains a synchronous transmitter-receiver (STR) and its control unit.

The 7701 system carries data through four basic phases of transfer: reading, transmitting, receiving, and writing. The two tape units (one at each terminal) are the input-output components, performing the reading and writing. The synchronous transmitter-receivers (STR's) act as the processing components. The tape units operate on demand from the STR's. Therefore, the functions of the STR's are described first, followed by those of the magnetic tape unit.

Functions of the Synchronous Transmitter-Receiver

The synchronous transmitter-receiver is a link between the input-output magnetic tape unit and the common carrier's modulation-demodulation equipment. The STR uses transistors and magnetic cores to insure maximum life and minimum maintenance.

The STR contains two independent sections, one for transmitting and one for receiving.

To transmit, the STR first calls for characters (one at a time) from the tape unit. It checks to see that these are valid characters and, if so, it changes the character code of the input device to a four-of-eight transmission code. Next, it serializes the character and feeds the bits to the modulator for transmission and it accumulates the longitudinal check bits of the transmission code for transmission to the receiver.

To receive, the STR first accepts serial bits from the demodulator and assembles (deserializes) these bits to form a character. Then it checks that each character received is valid, i.e., that it includes four 1's (marks) and four 0's (spaces). Next, it translates the four-of-eight character into the correct output code character and feeds these characters to the output device, one character at a time. Finally, it accumulates the longitudinal check bits of the transmission code and, on signal, compares the resulting character with that sent from the transmitting terminal.

Use of the four-of-eight code (Figure 2) combined with the longitudinal accumulation provides an extremely reliable two-way check of character transmission. Since every character (except the longitudinal check character) must contain exactly four 1's and four 0's to be valid, the only error that could pass this validity test would be an even number of switched bits ending up with four 1's and four 0's. However, at the end of the record, the transmitting STR sends a check character composed of a 1 bit in each of the eight positions which has, in the course of the record, accumulated an odd number of 1 bits. This check character is compared against the check character formed in the receiving STR by the same method. When any compensating switches of bits pass undetected through the character-by-character, four-of-eight, validity check, they cause unlike check characters to be formed at the end of the record at the two terminals and produce an error indication.

Additional reading, writing and write-read checking (odd and even validity) and still another longitudinal check are performed as functions of the magnetic tape unit, rather than the STR.

The means by which the various functions of the STR are carried out are described in "Principles of Operation."

Functions of the Magnetic Tape Unit

The magnetic tape unit, housed in the upper SMS cube of the 7701, consists of two parts—the "incremental tape transport" and its associated "incremental-operational tape adapter" (IOTA).

The IOTA is the control for the tape unit. The tape transport is called "incremental" because it moves tape over the read-write head in increments of .005 inch on demand from the STR. This .005-inch incremental movement, referred to as "stepping," is especially suited to character-by-character transmission from one magnetic tape to another. The special read-write head used in this tape unit makes possible the reading of either slow-moving or stationary tape.

The tape reels are mounted on hubs projecting from the front of the tape unit. A vacuum column and a pressure-sensitive switch are associated with each reel. They control the reel drive motor and make it possible for the tape reels to be started and stopped independently of tape motion past the read-

write head. The vacuum in the columns also provides tension to hold the tape in contact with the read-write head and to prevent buckling at the start and stop of tape motion.

The incremental-operational tape adapter (IOTA) is the tape transport control. It provides the control and information logic common to the operation of the tape unit and the STR. The IOTA contains three one-character registers through which input characters pass en route from the tape unit read head through the read-write register to the STR. Output characters do not pass through these registers. They pass directly through the read-write register into the write triggers and are written on tape.

Input-output characters may be in either binary or binary-coded-decimal form. The BCD character set (Figure 3) consists of 55 characters (plus a manually generated 56th character, the substitute-record character). In BCD mode, the IOTA checks that each character has an even number of 1 bits.

Binary code has a character set of 64 combinations of bits. The combinations are not listed here because the interpretation of binary tape characters differs according to their usage. In binary mode, the IOTA checks that each character, except the longitudinal check character, has an odd number of 1 bits. Before transmission, the operators set switches to make the operation of both terminals compatible with the tape to be transmitted. Tapes prepared by the 7701 are compatible with those prepared on the 7330, 727, 729 I, 729 II, or 729 IV tape units. Data is recorded at a density of 200 characters to the inch. At 1,200 bits-per-second transmission-line capacity, the maximum character transmission rate (and the rate of reading or writing by the magnetic tape unit) is 150 characters per second; at 600 bits-per-second transmission rate, the maximum character transmission (and reading or writing) rate is 75 characters per second. However, the rate of actual character transmission depends upon these factors:

1. Characteristics of the communication channel. These include propagation delay, turn-around delay, and line quality.
2. Tape record lengths.
3. Time delays in the terminal caused by passing over inter-record gaps.

The first of these three variables depends upon the nature of the particular transmission medium being used. With the full-duplex/half-duplex switch in full-duplex position and transmission on a full-duplex transmission circuit, there is no turn-around time (Figure 4).

The second variable, tape record length, has no limitation. However, records of from 300 to 3,000 characters are suggested. Shorter records are so frequently interspersed with inter-record gaps that average character transmission rate is low. Longer records can cause delay when an error automatically forces retransmission.

	SYMBOL	CARD CODE	BCD CODE						
1	(SPACE)	(BLANK)	C		A				
2	0	0				8		2	
3	1	1	C						1
4	2	2	C					2	
5	3	3						2	1
6	4	4	C				4		
7	5	5					4		1
8	6	6					4	2	
9	7	7	C				4	2	1
10	8	8	C			8			
11	9	9				8			1
12	A	12-1	C	B	A				1
13	B	12-2	C	B	A			2	
14	C	12-3		B	A			2	1
15	D	12-4	C	B	A		4		
16	E	12-5		B	A		4		1
17	F	12-6		B	A		4	2	
18	G	12-7	C	B	A		4	2	1
19	H	12-8	C	B	A	8			
20	I	12-9		B	A	8			1
21	J	11-1		B					1
22	K	11-2		B				2	
23	L	11-3	C	B				2	1
24	M	11-4		B			4		
25	N	11-5	C	B			4		1
26	O	11-6	C	B			4	2	
27	P	11-7		B			4	2	1
28	Q	11-8		B		8			
29	R	11-9	C	B		8			1
30	S	0-2			A			2	
31	T	0-3	C		A			2	1
32	U	0-4			A		4		
33	V	0-5	C		A		4		1
34	W	0-6	C		A		4	2	
35	X	0-7			A		4	2	1
36	Y	0-8			A	8			
37	Z	0-9	C		A	8			1
38	/	0-1			A				1
39	#	3-8	C			8		2	1
40	.	12-3-8	C	B	A	8		2	1
41	$	11-3-8		B		8		2	1
42	,	0-3-8			A	8		2	1
43	@	4-8				8	4		
44	¤	12-4-8		B	A	8	4		
45	*	11-4-8	C	B		8	4		
46	%	0-4-8	C		A	8	4		
47	&	12		B	A				
48	±	11	C	B					
49	Ø	12-0		B	A	8		2	
50	Ø	11-0	C	B		8		2	
51	(RM -)	0-2-8	C		A	8		2	
52	(GM -) 12-5-8 (705) or	12-7-8(7070)		B	A	8	4	2	1
53	(Delta)	11-7-8	C	B		8	4	2	1
54	(Segment Mark-SM)	0-7-8	C		A	8	4	2	1
55	(Word Separator) (1401)	0-5-8			A	8	4		1

NOTES:

Tape Mark (coded as 8421) may be written under manual contral and, when read, causes the machine to stop and signal the operator. This code is not transmitted.

Substitute character is C841 in BCD cade and 841 in Binary Code. This code combination can be received and written on tape but cannot be transmitted fram magnetic tape in BCD mode.

Listed are the Standard Characters for the Magnetic Tape Terminal, operating in Binary-Coded-Decimal Mode. All characters not listed are treated as errors, both in reading and writing magnetic tape.

Figure 3. BCD Code

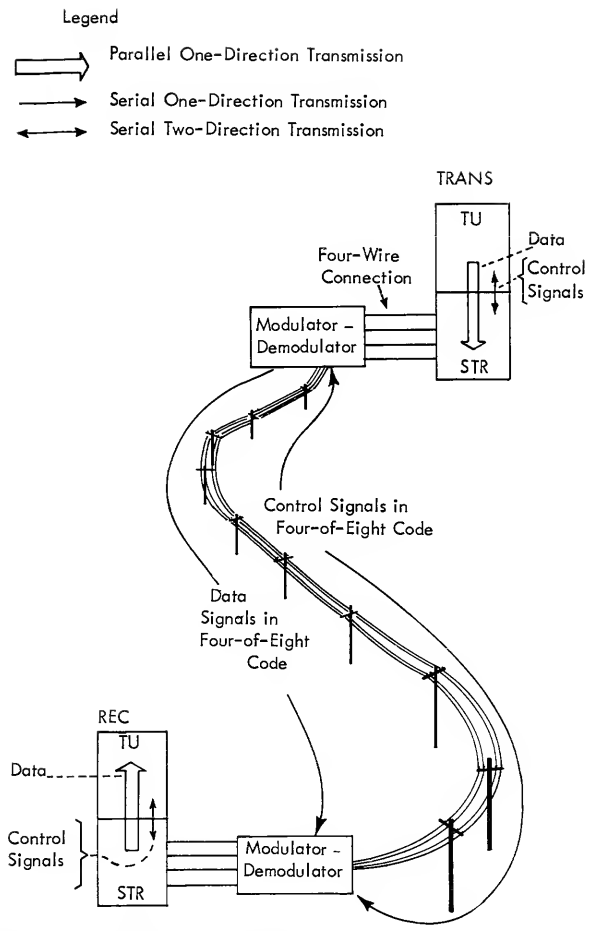


Figure 4. Four-Wire Transmission

The amount of delay caused by the third variable, inter-record gap, depends partly upon whether the tape unit is operating in write-only mode or in write-read mode. In write-only mode, the tape unit performs high-speed skips over the inter-record gaps. In write-read mode, the tape unit steps incrementally over the inter-record gap. The section "Principles of Operation" describes the reason for this difference in speed. The standard length of the inter-record gap is approximately .75 inch.

No code translation takes place in the magnetic tape unit itself. Whatever information appears on the seven tape information channels is accepted by the unit (if it passes the validity check) and is relayed, on demand, to the STR where it is again checked and translated. At the end of the record, a check character accumulated in IOTA must coincide with the check character on the input tape. If not, retransmission takes place.

Terminal Installation Specifications

Because systems using a 7701 consist of two parts, one supplied by IBM and one supplied by a communications company, the specifications of the part supplied by IBM (the terminal) are described in the following sections.

Power requirements are: 115 volts AC, plus or minus ten per cent; 60 cycles per second, plus or minus one cycle; 15 amperes; single phase. Power consumption is 115 volts, 11 amperes, 1.07 kilowatts or 3,650 BTU per hour. The power cord is about seven feet long. The maximum length of signal cable connecting the tape terminal to the modulation-demodulation unit is 50 feet.

The *dimensions* of the 7701 are: height, 58 inches; width, 29 inches; length, 31 inches.

The operating *temperature and humidity requirements* are: temperature, 50° to 90° Fahrenheit; relative humidity, 20% to 80%. Mylar* tape can be used with these temperature and humidity ranges. However, if acetate tape is being used in the terminal, the operating ranges are narrowed to: temperature, 65° to 80° Fahrenheit; humidity, 40% to 60%.

Either acetate or Mylar tape may be used on the 7701. However, the type of tape mounted on the receiving terminal must be usable on whatever tape unit is to later read the tape. Therefore, for guidance as to choice of tape (Mylar or acetate), consult the *IBM Magnetic Tape Units Bulletin,* G22-6510.

Common Carrier Services

In planning a tape terminal system, consider first whether it is possible to determine the number of records to be transmitted within a certain length of time. Doing this helps to decide whether message service or leased line service is preferable. Consult a representative of the communication company to determine which facilities can be provided, what rates apply, and when service can begin.

Any transmission medium with associated equipment that meets the standards of the Electronic Industries Association's *Recommended Standards 232,* "Interconnection of Data Terminal Equipment with a Communication Channel," is usable by the IBM 7701 Magnetic Tape Transmission Terminal.

In general, a circuit designed and maintained for message service or leased line service is suitable for tape terminal transmission. The terminals can be expected to operate satisfactorily over circuits providing communication of private-line quality.

* Trademark of the E. I. duPont de Nemours & Co., Inc.

Character mutilation can be caused by interruption of a wire circuit (or fading signals on a radio circuit) or by crosstalk, noise, telegraph signals, and other types of interference on wire circuits (or static on radio circuits). No two circuits are subject to the same type or degree of interference; thus it is impractical to establish any fixed rule as to how many records may have to be repeated in a given length of time. Character mutilation reduces the effective character rates shown in Figure 1.

Simultaneous opposite-direction signals must be provided, if the terminals are to operate in full-duplex mode. These signals are carried by four wires instead of the two wires used for half-duplex operation only. The 7701 retransmits immediately after incorrect data characters are sensed on four-wire circuits (Figure 4) or at the end of a record in which incorrect characters are sensed on half-duplex circuits (Figure 5). Half-duplex operation (one way at a time) involves "turnaround" time — the time required to reverse the direction of transmission in a communication channel.

Test facilities are incorporated in all 7701's. These test facilities localize trouble to the machine transmitting, the machine receiving, or to the transmission facility. Operators should check error indicators carefully before calling for service from either IBM or the communications company. Refer to "Error Checking Procedures."

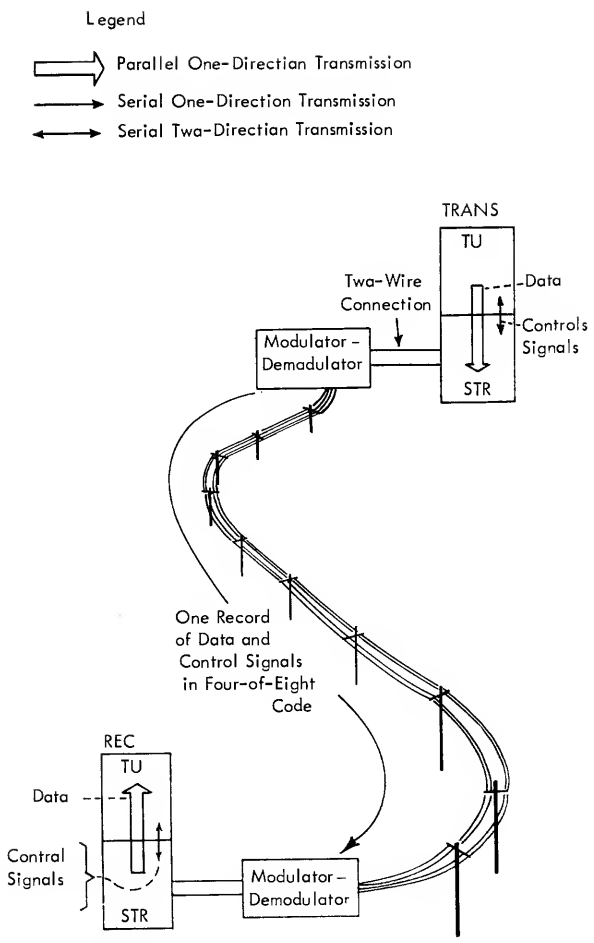


Figure 5. Half-Duplex Transmission

Data Flow in the Transmitting Terminal

The 7701, as a transmitting terminal, reads characters from tape, translates them from tape code (binary or BCD) to transmission code (four-of-eight), and sends them serially to the remote terminal (Figure 6).

As each character is read from tape, it is sent to IOTA (the control unit for the tape drive), where it is stored momentarily. At the proper time, the character is sent to the STR. In the STR, the character is translated to the four-of-eight transmission code. The character is then sent, a bit at a time, to the remote terminal.

The data checking consists of: (1) parity checking of tape characters, (2) checking of transmission characters for a legal four-of-eight code, and (3) checking of the entire record with a longitudinal record check. The longitudinal check uses a character accumulated by the STR at the transmitting terminal as it is sending a record. At the end of the record, this check character is sent to the remote terminal which compares it against the check character that it has accumulated independently.

Data Flow in the Receiving Terminal

The 7701, as a receiving terminal, accepts incoming bits, stores them until it has an entire transmission code character, translates this character into tape code (binary or BCD) and writes the character on tape (Figure 7).

The transmission characters are given a four-of-eight validity check; the tape characters are parity-checked. The longitudinal check is made as described earlier. A validity check of the written record may be made.

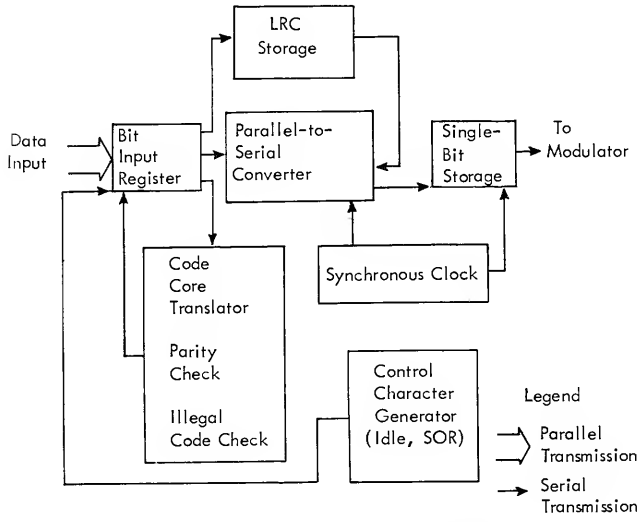


Figure 6. Data Flow in the Transmitting Terminal

Control Codes

In addition to transmitting data, the terminals have six control code characters, used by the terminals for communicating with each other (Figures 2, 8). These characters remain after assigning the 64 combinations of the input-output code to the 70 combinations available in the four-of-eight code. These characters are not written on the tape since they are only used for the control of the terminals. The codes are: (1) idle, (2) error and inquiry, (3) transmit leader, (4) control leader, (5) SOR-1 (start-of-record 1) or ACK-1 (acknowledge 1), (6) SOR-2 or ACK-2. Some of these are combined to form two-character sequences having their own distinct functions; one is used with data characters to denote other functions.

Idle

This character is sent when no data or other signals are available to send. It is used by the terminals to establish and maintain synchronism. It may be sent either during a record when a data character is not available or when no record is being transmitted. In the latter case, it is sent repeatedly by one terminal

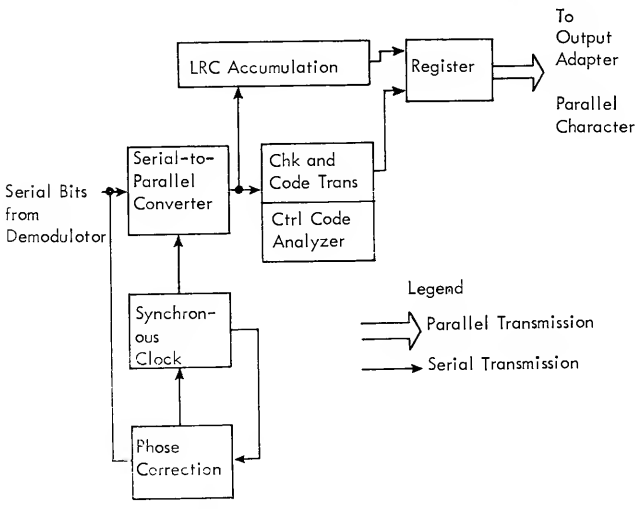


Figure 7. Data Flow in the Receiving Terminal

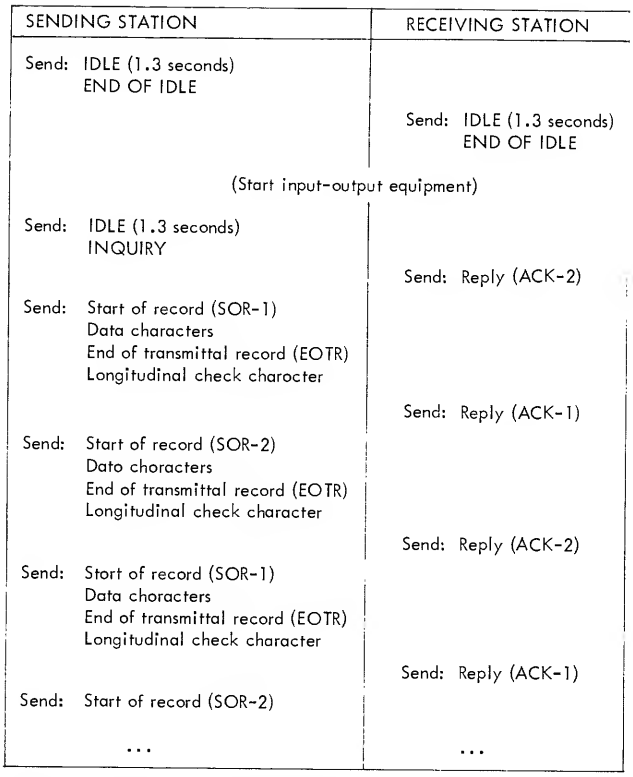


Figure 8. Sequence of Half-Duplex Control Signals

for about 1.3 seconds, after which an end-of-idle signal causes the other terminal to transmit idle characters for a similar time period.

The end-of-idle signal is a control leader followed by an idle character. If the transmitting terminal should send this during the record (indicating that it has dropped out of data condition), the receiving terminal would interpret it as an error.

Transmit Leader

This character is the first half of a two-character control signal sent by the transmitting terminal. It is used: (1) before a SOR-1 or SOR-2 to denote the beginning of a record, (2) before an inquiry to request a reply from the receiving terminal, and (3) before the longitudinal check character to denote end of the tape record (EOTR).

Control Leader

This character is used as the first character of any reply by the receiving terminal. These replies are ACK-1 or ACK-2 and error. It is used on the first character of a TEL (telecommunication alternate mode) or EOT (end of tranmission) signal. It is also used as a test pattern signal, should the customer engineer wish to supply a test signal (to the communication channel).

SOR-1 or ACK-1

This signal is called SOR-1 when sent (following a transmit leader) by the transmitting terminal. It denotes the start of a record and, also, the fact that it is an odd-number record.

If this character is sent (following a control leader) by the receiver, it is called ACK-1. This is the receiving terminal's reply to EOTR following an error-free record. The 1 means that the receiving terminal has now received an odd number of records.

SOR-2 or ACK-2

This character is used in the same manner as SOR-1 or ACK-1, except that it denotes an even-number record.

Inquiry or Error

This signal can be called either error or inquiry, according to its usage. If the transmitting terminal sends a transmit-leader followed by inquiry, it sends a request for the remote terminal to send a reply. This can occur either prior to starting a record (a request for permission from the remote terminal to start) or during transmission if the remote terminal fails to reply to an EOTR (end-of-transmittal record) signal.

If the receiving terminal finds that a record is in error, it sends a control-leader followed by error to tell the transmitter to repeat the record.

Manual Signals

These two-character signals consist of a control-leader followed by one of the data characters.

TEL

This signal may be sent by either terminal and indicates a change to the alternate telecommunication mode.

EOT

This signal signifies end of transmission.

Operation of the 7701 Terminals

Prior to transmitting, the switches on both terminals must be properly set as described in "Summary of Operating Procedures."

When the transmitting terminal has the first character ready for transmission, its STR will send an inquiry signal to the receiving terminal which will respond with an acknowledge signal. The inquiry signal is actually a transmit-leader character followed by an inquiry character. The acknowledge signal is a

control-leader character followed by an acknowledge-2 character denoting receipt of an even number of records (zero in this case). Upon receipt of the acknowledge signal, the transmitting terminal sends start-of-record, a transmit-leader and start-of-record 1. (The 1 indicates that this is an odd-number record; in this case, the first one.) The transmitting terminal's STR then accepts the first character from its IOTA, performs the translation to the four-of-eight transmission code, and sends the bits, one at a time, to the receiving terminal. The receiving terminal stores the bits, translates the character to tape code, and writes the character on tape.

When the first character has been sent, the transmitting terminal's STR accepts the next character from its IOTA. If its IOTA does not have the next character ready, the next character transmitted is an "idle" character. (The remote terminal does not write this character on tape since it is used for control purposes only.) This process of sending characters continues for the entire record. When the inter-record gap is sensed, the transmitting terminal's STR sends another transmit-leader character followed by the LRC character. If there are no errors, the receiving terminal sends back control-leader and acknowledge-1. This allows the transmitting terminal to start sending the next record.

If the previous record had been in error, then control-leader and error would have been sent back to the transmitting terminal and the previous record would have been sent over again. (To repeat a record, both tape units usually need to backspace.)

The transmitting terminal makes three attempts to transmit a record successfully. If the third attempt is in error, the terminals stop and the alarm is sounded.

Transmission of records continues (unless errors occur that cannot be corrected in the three attempts allotted) until either the transmitting terminal reads a tape mark or the receiving terminal senses end of tape. In either case, both terminals stop (after the last record is successfully completed) and the alarm sounds.

The 7701 Components

The STR is the part of the terminal that communicates between the modulator and the input-output unit. A standard IBM circuit package, it can perform this job with different types of input-output equipment. In the case of the 7701, it is used with the incremental tape unit and its IOTA. Since the STR and IOTA are not directly compatible, the 7701 adapter is used to connect the two units. The IOTA is the control unit for the incremental tape unit. Its functions include storing tape characters and timing of operations such as backspace. The incremental tape unit has logic of its own, consisting mostly of the motion controls and the read and write circuits. Since the STR and the tape unit have certain unusual features, these are described here.

Synchronous Transmitter-Receiver (STR)

Of the many functions performed by the STR, three areas deserve special mention. These are: the synchronization of the terminal with the remote terminal, the STR register, and the magnetic core arrays.

The synchronization of the terminal with the remote terminal is accomplished automatically when the terminals are connected via the transmission line and are turned on (Figure 9). The terminals alternately send out idle characters for about 1.3 seconds and then the end-of-idle signal, which causes the other terminal to do the transmitting. The idle characters are used by the receiving terminal to become synchronized with the transmitting terminal. When this synchronization is accomplished, the transmitting terminal can proceed to transmit records, if the terminals are otherwise ready. During the transmission of records, data signals maintain synchronism; when there are no data signals, idle characters keep the terminals in synchronism. A precision oscillator

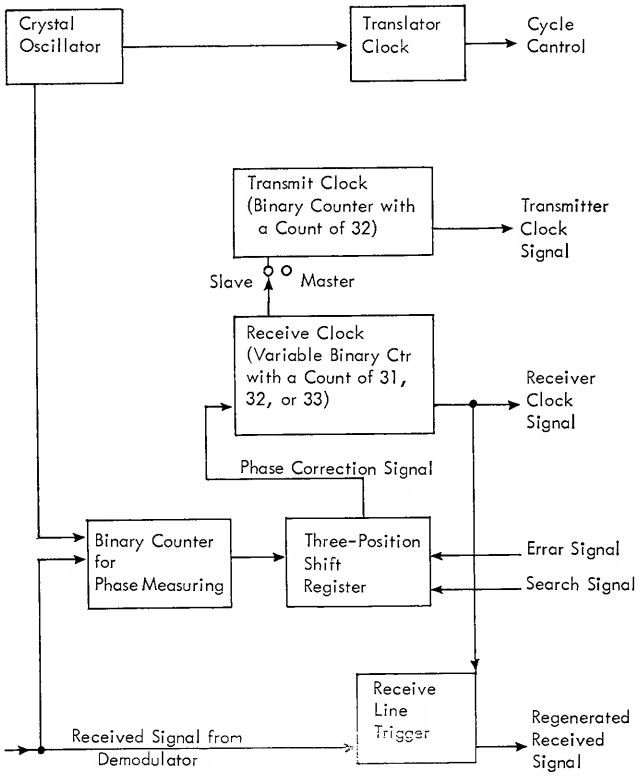


Figure 9. Synchronization

within the STR maintains synchronism during the brief interruptions caused by waiting for replies.

The STR register stores the eight bits that make up a transmission character, plus two control bits. When a character is received from IOTA, it is put into this register. The bits are then removed, one at a time, and sent to the modulator which sends them over the transmission line to the other modulator and terminal (Figure 10). The process of sending bits one at a time involves taking the bit away from the first position and then shifting all the other bits one position toward the first position. Thus, all the bits are eventually sent to the modulator. The shifting process is accomplished by transferring the bits in the register to one set of cores in another section of the STR (the analyzer plane). The contents of the cores are then put back into the register, except that each bit is displaced one position from where it originated.

When a character is being received from the demodulator (which, in turn, is receiving it from the transmission line), the bits are put into one of the register's triggers. After each bit is received, all bits are shifted one position. Thus, all the bits of a character will eventually be assembled in their proper order.

The STR has three core planes: the transmit translator, the receive translator, and the analyzer plane. These core planes are used for both storing information and translating from one code to another. The transmit translator changes tape code (BCD or binary) into the four-of-eight transmission code. The receive translator changes the four-of-eight transmission code back into tape code. The analyzer plane has several uses. These include shifting the bits in the STR register as a part of the serial-to-parallel and parallel-to-serial conversion, translation of the control codes, and storage of the longitudinal check character.

Incremental Tape Unit

The incremental tape unit has an unusual read-write head. This head permits reading and writing while the tape is stationary or moving at slow speed. The terminal takes advantage of this fact by moving only a character at a time, under control of the STR.

The head is also designed to permit reading characters from tape during a writing operation. This enables the terminal to check what is written on tape for validity. This checking takes place when the write-read switch on the operator's panel is turned to ON.

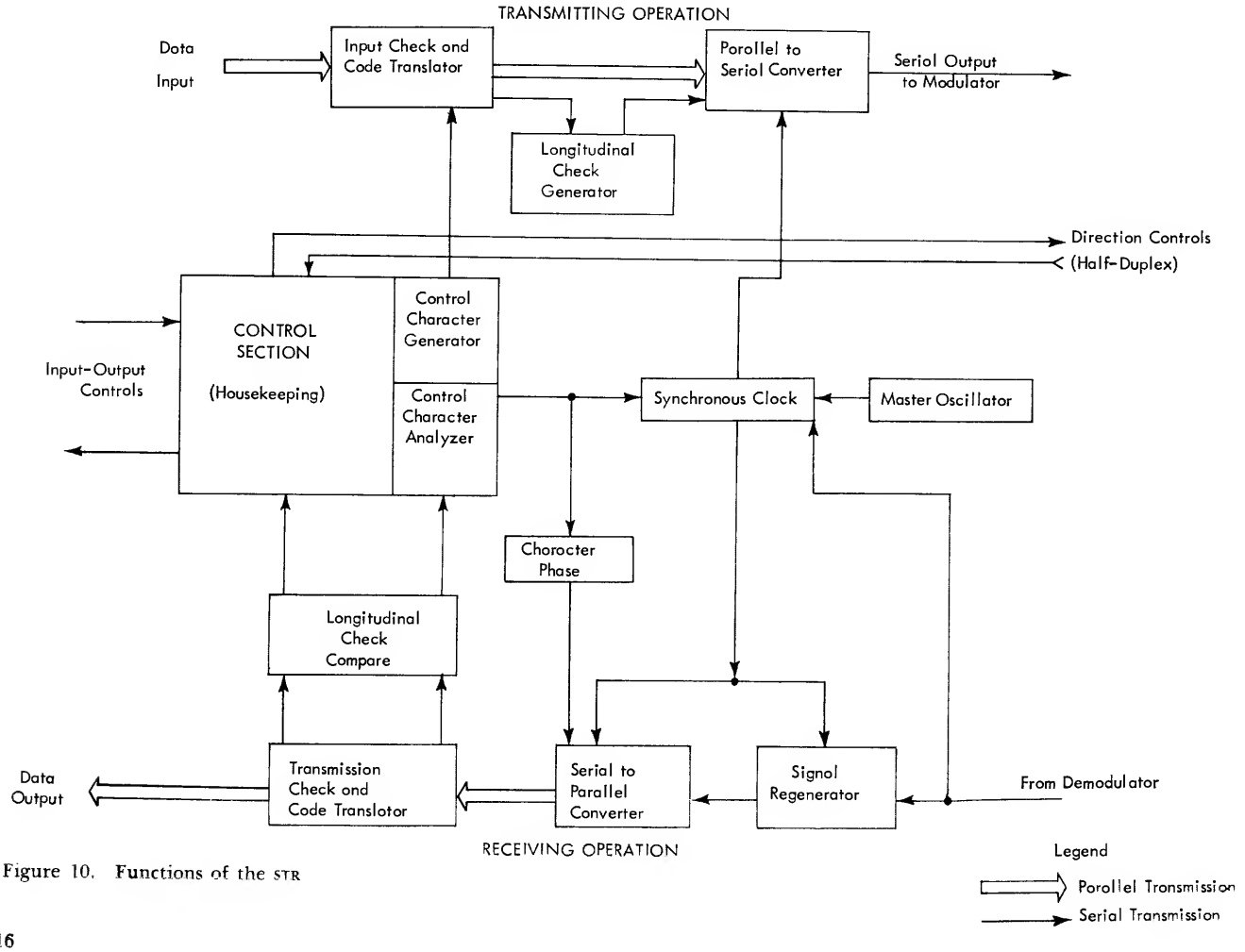


Figure 10. Functions of the STR

The operator panels are on the front and side of the upper SMS cube. The front panel contains all the lights and all but one of the keys and switches that the operator needs while the machine is in operation. The remaining switch is the record-substitution switch, located at the top right part of the side panel. The side panel contains status lights and several "preset" switches that must be set by the operator before operation begins. The lower portion of the side panel contains lights and switches to be used by the IBM customer engineer.

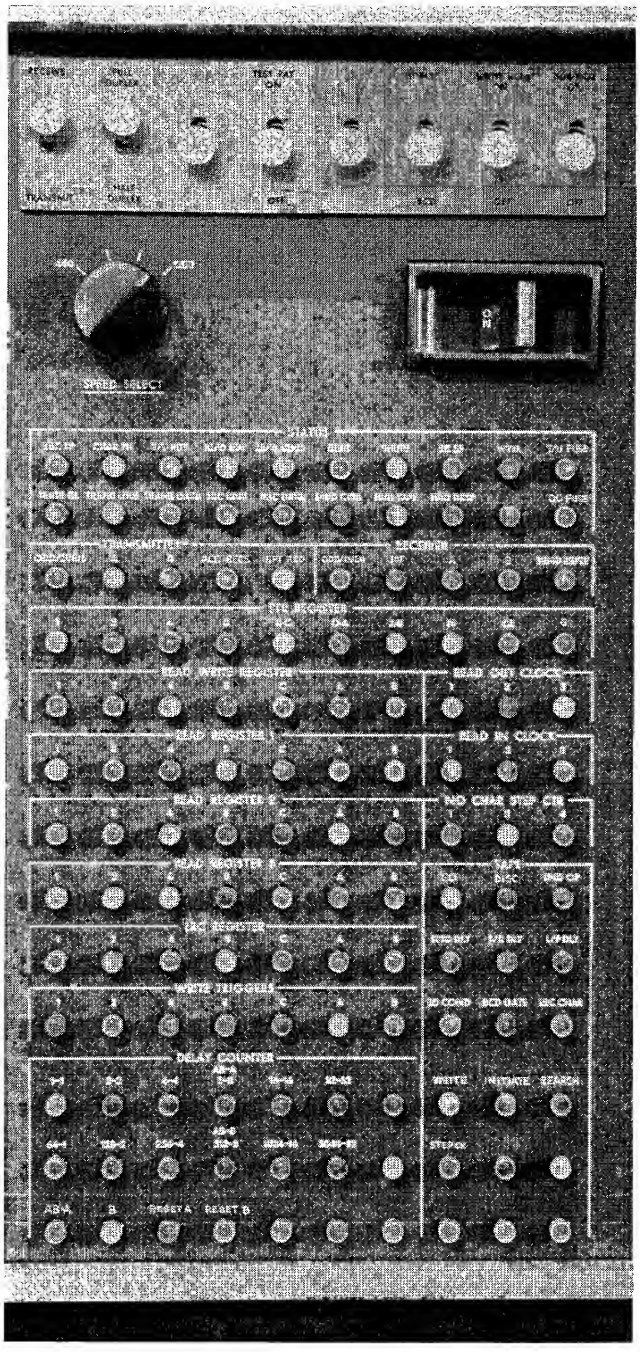


Figure 11. Operator's Side Panel

Preset Switches on the Side Panel

Because the operator must "preset" switches on the side panel prior to operating the controls on the front panel, the operator's portion of the side panel is described first, beginning with the top-row toggle switches (left to right) and proceeding downward (Figure 11.)

Rec-Trans (Receive-Transmit): The operator must set this toggle switch to the correct position before pushing the start key. Changing this switch while the machine is in operation does not affect the operation but does cause the alarm to be sounded. The magnetic tape transmission terminal must be brought to a complete stop before transmission direction can be changed.

Full-Duplex/Half-Duplex: This toggle switch must be preset by the operators at both terminals to match the type of transmission facility provided. In the half-duplex position, transmission of signals, as well as data, can be in only one direction at a time. In the full-duplex position, with the proper transmission facility, transmission of signals can be in both directions simultaneously. (Data transmission can be in only one direction at a time, but control signals can be transmitted in the opposite direction during data transmission.)

Test Pat (Pattern) On-Off: When the test pattern switch is on, the 7701 transmits a continuous test signal of alternate 1's and 0's. Normal operation cannot take place during this test and the ready light is held off. Turning this switch to ON when a record is in progress causes an error in transmission.

Binary-BCD: With this toggle switch, the operator selects whether the 7701 will check the tape character for even or odd parity. Thus, the transmitting operator must know whether the tape being read is a BCD or binary tape, and set the switch accordingly. The receiving operator must set the receiving 7701 to be the same as the transmitting terminal or the tape will be written incorrectly.

Write-Read On-Off: The write-read toggle switch is effective only when the 7701 tape unit is in receive status. When the switch is turned to ON, the terminal is in write-read mode. This means that the tape unit will read what it has written on tape and, thereby, insure that the tape is correctly written. When the switch is set to OFF, this particular check is not performed.

Sub-Rcd (Substitute Record) On-Off: This switch is a spring-return toggle switch. The operator at the transmitting terminal sets this switch to ON (by momentarily pressing the switch and then releasing it) after one or more transmission halts caused by read errors at the transmitting terminal. Using this switch causes the machine to transmit a one-character record (C-8-4-1 in BCD; 8-4-1 in binary) and then to reread the erroneous record, substituting the C-8-4-1 or 8-4-1 character for every illegal character *within that one record.* Each future erroneous record requires repetition of the same procedure. The only time that this switch is used at the receiving terminal is to restart after a record check stop.

Speed Selector: This rotary switch, located below the row of toggle switches, enables the operator to select the transmission speed compatible with the particular transmission facilities being used. The two transmission speeds are 1200 bits per second (150 characters per second) and 600 bits per second (75 characters per second).

Master Power On-Off: The master power switch, located to the right of the speed selector switch and below the top row of toggle switches on the side panel, controls the supply of power to the terminal.

In-Process Control Keys and Indicators, Front Panel

After the operator has correctly set the switches on the side panel, he turns his attention to the front panel. Here, at the extreme upper left is one row of four incandescent status lights displaying the status brought about by the preset switches just described. (Two other preset switches have lights elsewhere and are discussed later.)

Status Indicators (Figure 12)

The *receive* light is on if the side panel receive-transmit switch is set to REC. It is off if this switch is set to TRANS.

The *full-duplex* light is on when the full-duplex/half-duplex switch is set to FULL-DUPLEX. It is off if this switch is set to HALF-DUPLEX.

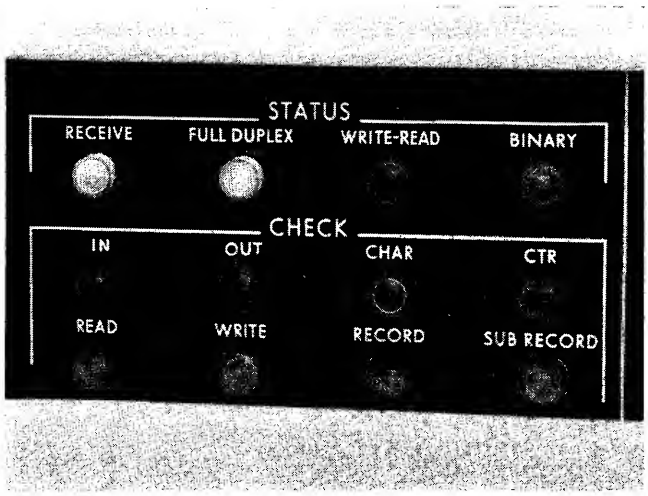


Figure 12. Status and Check Indicators on the Front Panel

The *write-read* light is on if the write-read switch on the side panel has been set to ON. It is off if the switch has been set to OFF.

The *binary* light is on if the binary-BCD switch on the side panel has been set to BINARY. It is off if the switch has been set to BCD.

To the right of the incandescent status indicators (Figure 13) are nine colored-lens indicators listed below in order as they appear from left to right.

The *power* light is on as long as the master power switch on the side panel is turned on and AC current is coming into the tape terminal.

The *run* light is on if the terminal is in run condition, that is, if the terminal is in ready condition (see ready light), the terminal is synchronized with the remote terminal, and the start key has been pushed. It remains on until a stop condition occurs.

The *ready* light is on when the modulation-demodulation unit and input-output unit are ready for operation, the test pattern switch is off, and the terminal is not in a test condition.

The *test pattern* light is on while the test pattern switch is on. To the right of the test pattern light is a blank lens that is not used.

The *file protect* light is on when the tape unit is loaded with a tape with no file protect ring. It is necessary to have a file protect ring on the tape reel to allow the tape unit to write. The ring should be removed after writing to prevent accidental destruction of valuable records. (This light is also on during a load-rewind operation.)

The *tape indicator* light comes on at the transmitting tape unit whenever it reads a first-character tape mark. It comes on at the receiving tape unit at the end of an error-free record during which the reflective strip for end-of-tape indication was detected. When the tape indicator is on, the alarm sounds; it is

then impossible to write anything on tape except a tape mark.

The *TEL* (telecommunication alternate mode) light comes on whenever a TEL signal is received from the remote terminal. It stays on until the start or stop key is depressed or the modulation-demodulation unit is switched out of data condition. The alarm sounds while the TEL light is on.

The *EOT* (end of transmission) light comes on when an EOT signal is received from the remote terminal. It stays on until either the start or stop key is depressed. The alarm sounds while the EOT light is on.

In-Process Control Keys

Below the colored-lens indicator lights on the front panel is a row of nine keys (Figure 13). From left to right, they are:

Stop: Pushing this key: (1) stops the machine after it successfully completes the transmitting or receiving of its current record, and (2) silences the alarm after error halts.

Start: Pushing this key enables the terminal to get into running condition if it is in ready condition and synchronized with the remote terminal. When the machine stops after three unsuccessful attempts to send a record, pushing the start key causes the machine to make three more attempts to transmit the record. The start key will also silence the alarm if it is on.

Between the start and load rewind key are three unused keys.

Load Rewind: This key is used to position a reel of tape at load point or to rewind a completed reel of tape. Two modes of rewinding are possible: (1) if magnetic tape is in the vacuum columns and the tape guide arm is down, pushing the key causes a backward search for load point; (2) with the tape guide up, pushing the key causes a high-speed rewind. After a high-speed rewind, the tape will have passed the load point. If the operator wishes to rerun the tape, he must manually advance the tape past load point so that the machine can make a normal start, the same as after a normal load operation.

The terminal will not rewind unless it has successfully completed the last transmitted record and either of the two following conditions exists:

1. The tape unit is in receive status and a tape mark has been written.
2. The tape unit is in transmit status and has received either a TEL or EOT signal, or has read a tape mark.

WTM (Write Tape Mark): Pushing the WTM key causes the tape unit to write a one-character record consisting of a tape mark (8-4-2-1). This key is operative only when the tape unit is in receiving mode and at least one of four conditions exists: TEL or EOT signal has been received, the tape indicator light is on, or a record check has been detected.

TEL (Telecommunications Alternate Mode): If this key is pushed by the operator at either terminal, it turns on the TEL light and alarm at the other terminal which, in turn, automatically replies with a TEL signal. However, this does not happen until the record then being written is successfully completed. TEL informs the other operator to switch to the alter-

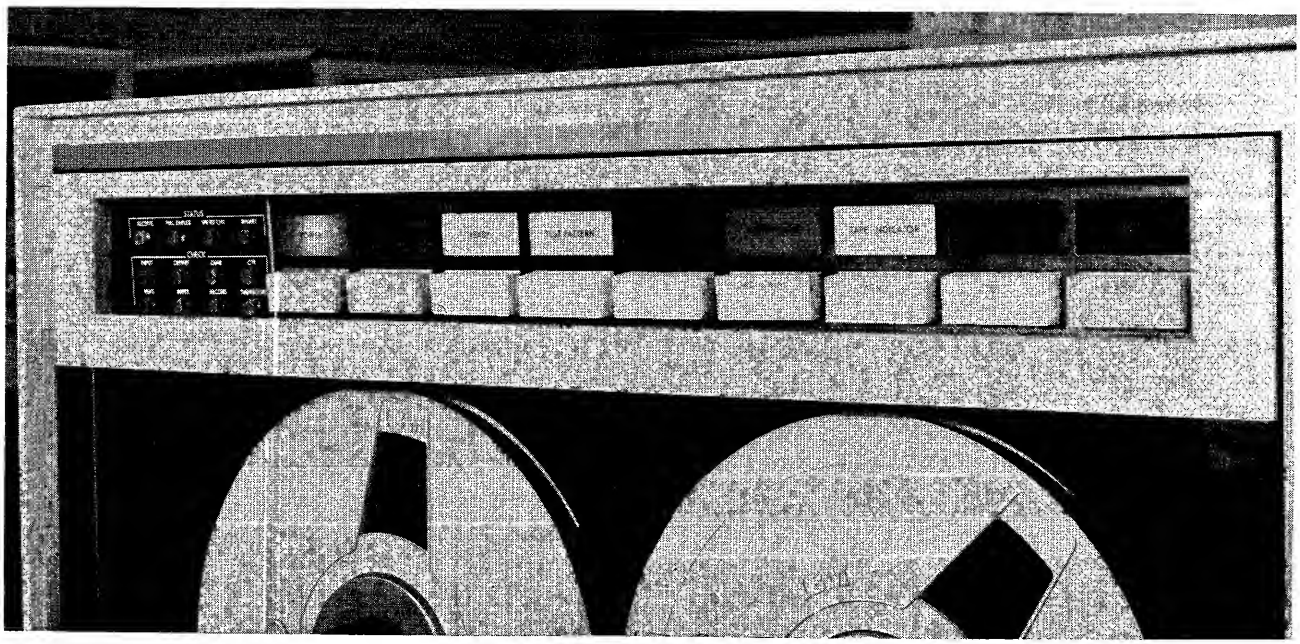


Figure 13. Complete Front Panel

nate method of communication. The terminal initiating the TEL signal continues to transmit the TEL signal until a TEL is received in reply.

EOT (End of Transmission). Pushing the EOT key normally signals end of file. If this key is pressed by the operator at either terminal, it turns on the EOT light and audible alarm at the other terminal (if the terminal whose EOT key is being pushed is in a stopped condition). The terminal receiving the EOT signal automatically replies with an EOT signal. The terminal initiating the EOT signal continues to transmit EOT until an EOT signal is received from the other terminal.

Check Indicator Lights

Beneath the row of status lights on the left end of the front operator panel is located another group of eight lights (Figure 12). These lights will be useful to the operator should the machine unexpectedly halt, since (with the colored-lens lights) they will usually indicate the cause of the stop. The lights are individually described here. For a discussion of the various combinations of these lights and the correct operator action, see "Error Checking Procedures."

Input: This light indicates that an error is detected by the transmitting terminal and that the error is caused within the terminal.

Output: This light indicates that an error is detected by the receiving terminal and that the error is caused within the terminal.

Char (Character): This light indicates that a transmission error has been detected. (This can occur only at the receiving terminal.)

Ctr (Counter): This light indicates that errors of some type have occurred during two or more successive attempts to transmit or receive a record. (Therefore, this light is also on when the alarm sounds at the end of a three-time failure to transmit or receive a record.)

Read: This light indicates that an erroneous tape character has been read by the transmitting terminal.

Write: This light indicates that a character to be written on tape by the receiving terminal has been detected as erroneous.

Record: This light indicates that the sending and receiving terminals are out of step. This indicator is detected at the receiving terminal and may denote a duplicate or lost record.

Sub (Substitute) Record: This light indicates that the substitute record switch on the side panel has been set to ON. The light stays on for the duration of the record in which a substitute character is used to replace any invalid character. The light remains off at all other times. This light comes on at the transmitting terminal only.

Indicator Lights, Side Panel

Indicator lights on the side panel (Figure 14) consist of status lights and character display lights.

Status Lights

The top two rows of incandescent lights on the side panel of the 7701 are called status lights. They provide the operator with specific indications of the operating status of the terminal. These twenty indicators are:

Rec TP: The receive-test-pattern light is on when the terminal is successfully receiving a test pattern.

Char Ph: The character phase light is on when character phase with the remote terminal is achieved.

TU Rdy: The tape unit ready light comes on when the tape unit itself is ready for operation.

M/D Rdy: An ON condition of the modulator-demodulator ready light indicates that: (1) the terminal has been connected to the M/D unit, and (2) that the

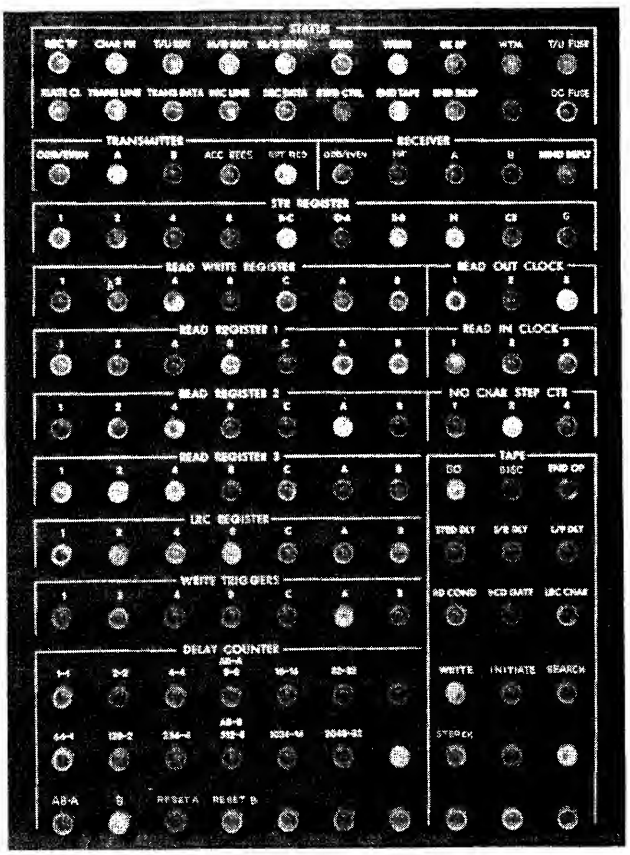


Figure 14. Indicator Lights on the Side Panel

M/D unit is in condition to transmit or receive data. This light is under the control of the M/D unit.

M/D Send: The modulator-demodulator send light comes on when the M/D unit is in a transmit condition.

Read: This light is on when the tape unit at the transmitting terminal is ready to read a record.

Write: This light is on when the tape unit at the receiving terminal is ready to write a record.

Bksp: The backspace light is on whenever the tape unit is backspacing.

WTM: The write-tape-mark light comes on momentarily after the operator pushes the WTM key.

TU Fuse: This light goes on whenever a fuse in the tape unit needs replacement by the IBM customer engineer.

Xlate Cl: The translator-clock light is on when the internal clock is operating properly.

Trans Line: The transmission line light goes on and off while the terminal is transmitting information to the modulator.

Trans Data: The transmit data light is on during the transmission of a record.

Rec Line: This light goes on and off while the terminal is receiving information from the demodulator.

Rec Data: The receive data light is on while the terminal is receiving a record.

Rwd Ctrl: The rewind control light is on when a rewind operation is possible after normal operation. This light is not turned on by the load rewind key.

End Tape: The end-of-tape light comes on when the reflective end-of-tape spot is sensed, when a TEL or EOT signal is received, or when a record check has been sensed.

End Bksp: The end-backspace light goes on at the completion of the backspace operation and remains on until a new command is given to the tape unit.

DC Fuse: This light goes on when a circuit breaker in one of the transistor power supplies needs resetting by the IBM customer engineer.

Character Display Lights

The eleven rows of incandescent lights below the status lights are for use by the IBM customer engineer. In normal operation, most of these lights go on and off too rapidly to permit observation.

Normal Operation

The normal operating procedure for the IBM 7701 Magnetic Tape Transmission Terminals is divided into two categories: "presets" and "in-process." "Presets" are the tape loading, switch settings, and the checking that must be done before data transmission begins. "In process" procedures are the changes that may need to be made by the operator during temporary halts in transmission.

Presetting may be done before or after the master power switch is turned on. Before attempting to understand the operating procedures of the 7701, it is important to understand that synchronization between two terminals is attempted as soon as the master power switches at both connected terminals are turned on (or, conversely, as soon as two power-on terminals are connected) with the subset switch turned to DATA. Some modulation-demodulation equipment does not have an alternate switch for DATA and TALK. On this equipment, merely lifting the receiver from the cradle and replacing it serves to put the terminal in TALK and DATA modes, respectively. However, this manual assumes and describes, throughout, the procedure of changing an alternate switch.

Synchronization occurs almost instantly and is an automatic function of the terminals. (No control from the operator is needed.)

A recommended supplement to the operation of the terminals, particularly with message service, is the use of some type of log sheet or log book as a record of transmissions, including length, quality, location of the remote terminal, and preset instructions.

Tape Load and Unload Operations

Before discussing the switch presets, this manual presents the procedure for a necessary phase of presetting, the process of tape loading (and unloading).

To load tape, open the front door of the upper SMS cube by depressing the latch at the right-hand side of the door frame. As soon as the front door has swung open, pull down the three panel doors at the front of the two vacuum columns and the read-write head (Figure 15). On the inside of the cover to the read-write head is a diagram of the method for threading tape.

Be sure that the vertical-column rewind arm (extending up from the top of the tape guide arm) is pushed to the right so that the tape guide arm is raised before beginning actual tape loading. Check that the file protect ring is in the reel for receiving and out of the reel for transmitting.

Place a reel of tape on the left tape hub so that the tape end comes off the right-hand side of the reel. The hub contains a rubber rim that grips the reel tightly when the knob is tightened. When loading, push the reel firmly against the stop on the mounting hub to insure proper alignment. Always be careful that the hub knobs have been tightened. However,

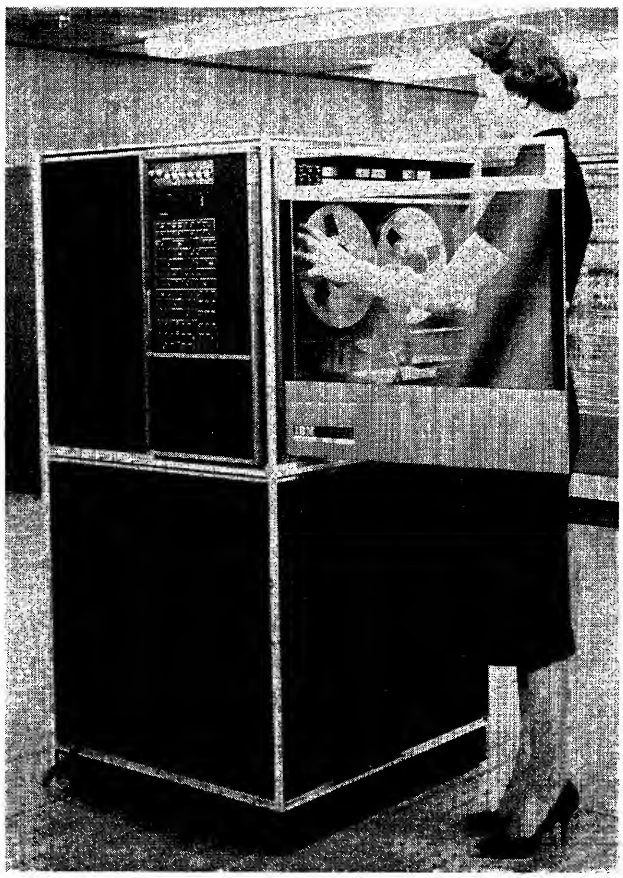


Figure 15. Loading the Tape Unit

do not use excessive force when tightening hub knobs, for this tends to strip the threads.

Thread the tape as shown by the diagram in the machine.

Fasten the tape on the take-up reel, as on any tape unit, by holding it against the reel spool and turning the reel several turns in a clockwise direction. Continue to turn the receiving reel until the reflective spot has *passed* the read-write head. Now, close the three panel doors enclosing the read-write head and the two vacuum columns. Manually, turn the tape reels (the left-hand reel in a clockwise direction, the right-hand reel in a counterclockwise direction) until the tape in the columns is stabilized as shown in the frontispiece. Lower the tape guide arm by pushing the rewind arm to the left. Doing this causes the vacuum motor to become operative.

Close the large front door to the tape unit. Push the load rewind key. The tape unit will move the tape backward until the reflective spot is sensed, thus putting the tape in the correct initial position.

To unload tape, open the front door of the tape unit and lift the tape guide arm by pushing the rewind arm to the right. Now, close the front door and push the load rewind key. The tape now rewinds at high speed (about 100 inches per second). If the tape does not rewind, check that the following conditions are satisfied: (1) a tape mark has been written (receiver only), (2) the tape guide arm is up, (3) the tape is out of the vacuum columns, (4) the front door is closed, and (5) the load rewind key has been pushed. Failure to meet any of these conditions could cause the tape not to rewind.

Normal Start at the Transmitter

Switch Presets for Prescheduled Transmission: Normally, the alternate switch located on the modulation-demodulation unit is kept at the alternate setting so that an audible signal, such as the telephone ring or telegraph signal, will summon the attention of the operator, should someone at another terminal desire to communicate with him. Although the alternate-communication setting of the alternate switch might be labeled by any name appropriate to the type of communication, this manual calls it the TALK setting, simply for brevity and simplification. The other setting of the alternate switch permits data transmission and is here labeled DATA.

As the time approaches to transmit from the terminal, the operator turns on the master power switch, sets the full-duplex/half-duplex switch, sets the binary-BCD switch, sets the transmit-receive switch to TRANS (at the transmitting terminal), checks that the speed selector switch is turned to the proper setting, loads the tape, checks that the file protect light is in the correct status, presses the load rewind key, and then either sets the alternate switch at the modulation-demodulation unit to DATA if transmission is to be over a leased line or sets it to TALK and dials the number of the receiving terminal if it is a message service transmission. If the transmission takes place over a telephone message service line and the connection is made by an operator rather than by direct dialing, the 7701 operator should tell the telephone operator that this is to be data transmission rather than voice transmission and ask her to relay this information to all other operators involved in making this connection. The notification is essential because, with operator-placed calls, the operator checks long-held, long-distance connections for a possible faulty release. If she hears no conversation, she assumes that the call has been completed and disconnects the lines. If, however, the operator who connects the lines knows that this is to be a data transmission, she can tag the line

so that no disconnect will be made until the lights go out indicating release of the lines.

Usually, the transmitting and receiving operators will have prearranged transmission time schedules and operating procedures so that a minimum of time must be spent in the "alternate" method of communication—time devoted only to discussing *exception* procedures, such as the use of binary-coded tape instead of BCD tape (if BCD tape is usually transmitted).

Alternate-Communication Negotiations for Unscheduled Transmission: Assume that this is not a prescheduled transmission and that the alternate method of communication is a message service telephone line. The transmitting operator dials the telephone number of the receiving terminal. Once the connection has been made, he briefly informs the receiving operator of his desire to transmit and the settings of his preset controls. The transmitting operator should also indicate to the receiving operator the estimated length of the transmission file, if known.

Upon ending negotiations with the receiving operator, the transmitting operator turns the alternate switch to DATA, presses the start key, and watches for the run light to come on. If it comes on within a reasonable time (allowing for the receiving terminal to be preset), the transmitting operator need not attend the machine further. The audible signal will summon the operator whenever the transmission is halted by an end-of-file, end-of-reel, or error condition.

If the run light does not come on within a reasonable time, the transmitting operator should check first the indicator lights on the front panel that correspond to the preset switches already set on the side panel. Next, the operator should check the setting of the side-panel switches and the status of lights such as the modulator-demodulator ready light and tape-unit ready light. If all switches and lights are correct, the transmitting operator should notify the receiving operator to make a similar check and compare settings between the two terminals, to make sure they are compatible. When the erroneous setting is discovered and corrected and the run light comes on, the operator may leave the terminal to automatically transmit and signal him at the end of transmission.

If the operator were initiating transmission on a leased transmission service and the time and conditions of transmission had been previously arranged (normal procedure), the operator would set the alternate switch to DATA, preset the side-panel keys and switches, load the tape, press the start key, and wait for the run light to come on at the prearranged time of transmission. (If the run light did not come on within a reasonable time, the operator would check his own settings and, if necessary, call the other operator to ascertain the cause of delay.)

Normal Start at the Receiver

Switch Presets for Prescheduled Transmission: The operator who is readying a receiving terminal for a prearranged transmission would (prior to the scheduled time of transmission) turn the alternate switch on the modulator-demodulator to DATA, turn on the master power switch, adjust the full-duplex/half-duplex switch to the proper setting, set the BCD-binary switch to the predetermined setting, set the receive-transmit switch to REC, check that the speed selector switch is correctly set, load a tape reel containing a file protect ring, press the load rewind key, set the write-read switch to the desired position, push the start key, and wait for the run light to come on at the appointed time of transmission. If it does not come on, the receiving operator should investigate his own presets and indicator lights—power light (on), full-duplex light, binary light, receive light (on), file-protect light (off), write-read light, and ready light (on). If (after a reasonable allowance of time for tardiness on the part of the transmitting operator) the run light still does not come on, the receiving operator should switch to TALK and check with the transmitting operator as to the cause of the delay. If the receiving operator receives a busy signal after dialing the transmitting terminal, the operator should press the TEL key (Figure 16), to sound an alarm at

Figure 16. Alternate Communications for "Preset" Instructions

the other end. This indicates to the other operator that he should turn the alternate switch to TALK and pick up the receiver.

Alternate-Communication Negotiations for Unscheduled Transmission: If the operator is called by a transmitting operator to receive an unscheduled transmission, he should make a note (perhaps on a preprinted log) of all pertinent facts required for presets. Both operators should keep conversation time at a minimum, and follow some check list to insure covering all necessary points in one short conversation. After the conversation, both operators should turn the alternate switch to DATA and the receiving operator should carry out the preset procedures as quickly as possible. His preset procedure, after having received instructions from the transmitting operator, is the same as if he were preparing for a prearranged data transmission.

Normal End-of-File Halt at the Transmitter

The term "end of file" here applies to the reading of a tape mark. The first indication of an end of file that an operator receives is the audible signal. Of course, the audible signal may indicate other types of halts, but when the *transmitting* operator sees that the tape-indicator light is on, he knows that the *transmitting* tape unit has read a tape mark and has reached the end of the last record on the tape. He then presses the stop key to silence the alarm and, if this is the last record to be transmitted, he presses the EOT key to signal the receiving terminal to sound an alarm, alerting its operator to the halt for end of transmission.

Usually, pushing the EOT key is enough notice for the transmitting operator to send to the receiving operator. Having done this, the transmitting operator opens the door of the tape unit, pushes the rewind arm to the right, closes the door of the tape unit, and presses the load rewind key. As soon as the tape is rewound, he unloads the tape. Since no more records are to be transmitted in this file, the operator readies his machine for whatever operation is scheduled next, or turns the alternate switch to TALK. If more reels are to be transmitted and the transmitting operator does not wish to have the receiving tape changed, he does not press the EOT key, but proceeds with the normal unload and reload and preset operations. When he presses the start key, the run light should come on immediately if the tape at the receiving terminal has not coincidentally come to the end of the reel at the same time. Allowing for such a possibility, a few minutes should be permitted to pass before calling the receiving terminal to find out the reason for the delay.

Normal End-of-File Halt at the Receiver

The term "end of file" here applies to the end of reel or to the end of the last record to be received. Like the transmitting operator, the receiving operator receives the first indication of an end-of-file halt by the sound of the audible signal.

If the operator sees a tape-indicator light on, he knows that the reflective spot on the tape has been sensed and that the machine has halted at the end of the record in which it was sensed. In this case, he presses the write-tape-mark key, rewinds the tape, unloads the reel, loads the new reel, lowers the tape guide arm, pushes the load rewind key, and pushes the start key. The run light should come on immediately, as the transmitting terminal has been sending idle signals all this time, waiting for the receiving terminal to come back into run condition.

Now, suppose that the receiving operator hears the audible signal and sees the EOT light, instead of the tape-indicator light. This means that the transmitting operator has pushed the EOT key signifying end of transmission. The receiving operator has the option of writing a tape mark and rewinding the tape, or writing the tape mark and not rewinding (the purpose being to separate files from the same or different terminals), or merely continuing to receive other information without writing a tape mark. These options depend upon the policy of each installation.

Normal Halts Other than End of File

The most frequent reason, other than end of file, for bringing data transmission to a halt is to use the alternate method of communication. Either operator can accomplish this by the following procedure:

1. Press the TEL key. This halts both terminals after they have completed the record currently being transmitted and causes the remote terminal to send a signal back to the originating unit, sound the alarm, and light the TEL light.
2. Switch to the alternate method of communication, following the procedure of the installation.
3. After the alternate communication is finished, turn the alternate switch back to DATA, push the start key, and watch for the run light to go on. As soon as both operators have pushed the start keys, the terminals continue transmitting from the point of interruption.

Error Checking Procedures

The 7701 Magnetic Tape Transmission Terminal *operator is not normally concerned with any of the error lights until the tape terminal halts and the*

alarm sounds. The audible alarm has a volume control that may be turned up to summon an operator who is not in the immediate area. The audible alarm also has one remote outlet that can be used for an additional loud speaker (not supplied). When the audible signal draws the operator's attention to the tape terminal, a glance at the error indicators usually shows the operator the nature of the error. The light or the combination of error lights determines the correction procedure. The possible reasons why the audible alarm might sound are:

1. The TEL signal has been received.
2. The EOT signal has been received.
3. The terminal has sensed a first-character tape mark (transmitter) or a reflective strip (receiver). (The tape indicator light is on.)
4. The receiver-transmit switch has been changed while the terminal was in run condition.
5. The start key has been depressed when the terminal was not in ready status or the remote terminal has power off.
6. The door of the tape unit has been opened while the terminal was in run condition.
7. There is loss of synchronism with the remote terminal.
8. The terminal has gone out of ready status while in run condition.
9. The terminals have made three unsuccessful attempts to transmit one record:
   a. Because a transmission error occurred in each of three transmissions of a single record.
   b. Because the transmitting terminal reads one or more invalid characters from tape.
   c. Because the receiving terminal (in write-read mode) reads back one or more invalid characters from the output tape.
   d. Because any combination of a, b, or c occurred during three attempted transmissions.
10. The receiving terminal has sensed a missing or duplicate record.

At the transmitting terminal, a frequent combination of check indicators at the time of a halt is the following: input, read, and CTR indicators. The input check indicator comes on whenever the transmitting terminal detects an error (as explained previously). The read light shows that the error is in reading. The CTR light indicates that a counter has counted two or more attempts to read the record in error.

When the operator sees this combination, he has two alternatives: (1) to push the start key to try three times more to read successfully, or (2) to push the substitute record key, causing the transmitting terminal to send a one-character record (C-8-4-1 in BCD; 8-4-1 in binary) to be written on the receiving tape. The transmitting terminal then substitutes that character for every invalid character throughout the previously untransmittable record. As soon as the transmitting operator presses the substitute record key, the substitute record light comes on and remains on until the end of the record.

If the input check indicator comes on alone, the operator should push the start key. If the halt (with the input light) persists, the operator should push the substitute record key, since there may be an erroneous record on tape. If the check still persists, call the IBM customer engineer.

If the alarm sounds and no error indicator lights are on, the machine status should be checked and corrected where necessary. See "Table of Error Checking Procedures."

At the receiving terminal, the following combinations of lights may be encountered.

One combination is the CHAR and CTR check indicators. The CHAR (character) indicator signifies that a transmitted character is in error. Having diagnosed the source of the error, the operator should first push the start key to try again three times to receive the record.

If the interference persists and the transmission is taking place on a telephone message service, the operator should press TEL, switch to TALK, and determine which operator should attempt to get a new and better connection. Usually, however, the bad connection makes conversation impossible and the 7701 operator should tell the local telephone operator that this line is transmitting unsatisfactorily and ask for rerouting.

If transmission is over leased lines, and the interference persists, wait a few minutes and try again. After a reasonable delay time, report the trouble to the common carrier.

Another combination of check indicators at a receiving terminal (occurring only in write-read mode) is: output light, read light, and CTR light. The functions of these lights have been previously explained. The read light, at the receiver, indicates that an invalid character has been sensed on the "receive" tape. When the operator sees this combination, he restarts his machine by pressing the start key. The machine, on the assumption that tape is defective in this area, skips forward three and three-fourths inches and then writes the record on a new section of tape. If the recording error is caused by dust particles or some other minute imperfection on the output tape and if the records are not excessively long, the area of bad tape will be passed by this skip. If the writing remains unsuccessful, after several depressions of the

start key, the operator must write a tape mark, rewind tape, and reload another reel. If the output error should still persist, he should notify the remote operator of an indefinite delay and call an IBM customer engineer. *Operating in write-read mode prevents incorrect recording.*

Another error indication that may appear at the receiving terminal is the record light. The record light comes on rarely. It indicates that a record may, by some abnormal combination of circumstances, have been lost or duplicated. The suggested procedure for the receiving operator to follow is this: (1) write one or more tape marks (depending on the policy of the installation), and (2) push the substitute record switch to ON, causing the SOR's and ACK's to become similar in odd-even count so that transmission can continue.

If the output and CTR lights come on, simply push the start key. If the error persists, call the IBM customer engineer.

If the audible alarm sounds and no error indicator light is on, check the machine status and make necessary corrections. See "Table of Error-Checking Procedures."

Normal Start at the Transmitting Terminal (Prescheduled Transmission)

Prior to the Prearranged Time of Transmission:

1. Turn the master power switch to ON.
2. Set the full-duplex/half-duplex switch to match the communication system.
3. Set the binary-BCD switch to match the tape being transmitted.
4. Set the transmit-receive switch to TRANS.
5. Check that the speed selector switch is set as prearranged.
6. Load the tape.
7. Press the load-rewind key to bring tape back to load point.
8. Check that the file protect light is in the correct status.
9. *If on a leased line,* set the alternate communication switch on the modulation-demodulation unit to DATA.

   If on a message service line:

   a. Set the alternate switch on the modulation-demodulation unit to TALK.
   b. Dial, or ask the operator for, the number of the receiving terminal. If an operator makes the connection, inform her that this is to be data transmission rather than voice conversation.
   c. As soon as the connection is made, set the alternate switch to DATA.
10. Check that the ready light is on.

At the Prearranged Time of Transmission:

11. Push the start key. If the alarm sounds when the start key is pushed, check the status lights on the side of the terminal. The character phase light indicates that the remote terminal is in synchronization with the home terminal.
12. Check that the run light comes on. If it is not lighted within a few minutes, follow the procedure described in step 12 of "Normal Start at the Receiving Terminal (Unscheduled)."

Normal Start at the Transmitting Terminal (Unscheduled Transmission)

1. Turn the master power switch to ON.
2. Set the full-duplex/half-duplex switch to match the communication system.
3. Set the binary-BCD switch to be compatible with the type of file to be transmitted.
4. Set the transmit-receive switch to TRANS.
5. Check that the speed selector switch is set correctly.
6. Load the tape.
7. Press the load rewind key to bring tape back to load point.
8. Check that the file protect light is in the correct status.
9. Turn the alternate switch on the modulation-demodulation unit to TALK.
10. *If on a leased line,* push TEL, and pick up the receiver or initiate a telegraph message, over the alternate communications means.

    If on a message service line, dial the number of the receiving terminal.
11. Communicate with the operator at the receiving terminal as follows:
    a. Describe switch settings at the transmitting terminal (preferably from a previously prepared check-off list).
    b. Describe the approximate length of file (if known).
12. Turn the alternate switch to DATA.
13. Check the ready light.
14. Push the start key.
15. Check that the run light comes on. If it does not come on after a few minutes, follow the procedure described in step 12 of "Normal Start at the Receiving Terminal (Unscheduled)."

Normal Start at the Receiving Terminal (Prescheduled Transmission)

Prior to the prearranged time of transmission:

1. Turn the master power switch to ON.
2. Set the full-duplex/half-duplex switch to match the communication system.
3. Set the binary-BCD switch to match the tape used.
4. Set the transmit-receive switch to REC.
5. Check that the speed selector is set as prearranged.
6. Load a tape reel (with a file protect ring).
7. Press the load rewind key to bring the tape back to load point.
8. Check that the file protect light is off.

9. Set the write-read switch as prearranged.
10. *If on a leased line,* turn the alternate communication switch on the modulation-demodulation unit to DATA.
    If on a message service line, turn the alternate switch on the modulation-demodulation unit to TALK. (This switch is normally set to TALK whenever data transmission is not taking place.)
11. Check the ready light.

At the Prearranged Time of Transmission:

If on a leased line:

12. Push the start key.
13. Watch for the run light to come on. If it does not come in within a few minutes, follow the procedure described in step 12 of "Normal Start at the Receiver (Unscheduled)."

If on a message service line:

12. Expect a call or message from the transmitting operator at the prearranged time.
13. After the pretransmission communication from the remote operator, switch to DATA.
14. Push the start key.
15. Watch for the run light to come on. If it does not come on within a few minutes, follow the procedure described in step 12 of "Normal Start at the Receiving Terminal (Unscheduled)."

Normal Start at the Receiving Terminal (Unscheduled)

1. Make note of the transmitting operator's presets, and other guiding information such as the approximate length of file to be transmitted.
2. Turn the master switch to ON.
3. Set the full-duplex/half-duplex switch as arranged with the transmitting operator.
4. Turn the binary-BCD switch to the setting compatible with the transmitting terminal.
5. Set the transmit-receive switch to REC.
6. Check that the speed selector is set correctly.
7. Load the tape reel if necessary (and check that the file protect light is off).
8. Set the write-read switch according to the policy of the installation, or secondly, according to the request of the transmitting operator.
9. Turn the alternate switch on the M/D unit to DATA.
10. Check the ready light.
11. Press the start key.
12. Watch for the run light to come on, before leaving the machine unattended.

    If the run light does not come on within a few minutes:

    a. Check the switch settings.
    b. If there is no error, press TEL.
    c. Switch to TALK.
    d. Compare the switch settings with those of the remote operator.
    e. As soon as the switch settings are made compatible, switch back to DATA, and discontinue administrative communication.
    f. Push the start key. As soon as this has been done at both terminals, transmission should take place.

Normal End-of-File Halt at the Transmitter

SIGNALS: audible alarm and tape-indicator light.

PROCEDURE

1. Press the EOT key.
2. Open the tape unit door.
3. Push the rewind arm to the right.
4. Close the tape unit door.
5. Press the load rewind key.
6. As soon as tape is rewound, unload it.
7. Prepare for the next job (receive or transmit) or shut power off and turn the alternate switch to TALK.

Normal End-of-File Halt at the Receiver

SIGNALS: Either (1) the audible alarm and tape indicator light, or (2) the audible alarm and the EOT light.

PROCEDURE FOR (1)

1. Press the WTM key.
2. Open the tape unit door and push the rewind arm to the right.
3. Close the tape unit door and press the load rewind key.
4. As soon as the tape is rewound, unload it.
5. Load another reel with the file protect ring.
6. Push the load rewind arm to the left.
7. Push the load rewind key.
8. As soon as the load point is reached, check the file protect light and push the start key.
9. The run light should come on.

PROCEDURE FOR (2)

1. Press the WTM key.
2. Open the tape door and push the rewind arm to the right.

3. Close the tape door and press the load rewind key.
4. Unload tape.
5. Get ready for the next job, or turn the power off and turn the alternate switch to TALK.

Interrupting Data Transmission for Alternate Mode Communication

If you are initiating the interruption:

1. Press the TEL key and wait for a reply.
2. Switch to TALK.
3. Pick up the receiver or otherwise initiate communications and wait for the remote operator to respond.
4. At the end of the communication, switch back to DATA.
5. Push the start key.
6. Watch for the run light to go on. If the alarm sounds, the remote terminal has not switched to DATA.

If you are to receive an alternate mode communication, the audible alarm will sound and the TEL light will be on.

1. Either pick up the telephone receiver or otherwise respond to the other terminal.
2. After the communication is completed, switch to DATA and push the start key.
3. Watch for the run light to come on. If it does not, the remote terminal has not been switched to DATA.

Table of Error-Checking Procedures

SIGNALS	TYPE OF ERROR	RECOMMENDED PROCEDURE
At the Transmitting Terminal		
Audible alarm Input light Read light CTR light	Read	1. Push the start key for three more attempts to read successfully. 2. Push the substitute record key to insert the special substitute character *for one record* and then continue normal transmission.
Audible alarm Input light CTR light	Machine	1. Push the start key. 2. If error persists, push the substitute record key, since the trouble may be an erroneous character on tape. 3. If error still persists, call the IBM customer engineer.
Audible alarm	1. Accidental switching of the Rec-Trans switch, or 2. Tape unit door open, or 3. M/D not ready, or 4. Not in character phase	1. Turn receive-transmit switch to TRANS. 2. Close door. 3. Turn alternate switch to DATA. 4. Check that remote terminal is properly preset.
At the Receiving Terminal		
Audible alarm Character light	Transmission-medium character mutilation	1. Push the start key. *If interference persists and transmission is on telephone message service line:* 2. Press the stop key. 3. Press TEL. 4. Switch to TALK. 5. If conversation is possible, tell remote operator the reason for delay. 6. Have originating terminal operator call the local communications operator to notify her of line trouble and request rerouting; or, if conversation is impossible, ask for rerouting from the receiving terminal. *If interference persists and transmission is on leased line:* 2. Delay transmission and try again. If still three errors, check with transmitting operator whether transmitting terminal is operating correctly. If it is, call the common carrier and report the difficulty.
Audible alarm Output light Read light CTR light	Invalid character on receiving tape	1. Press the start key. 2. If error persists, press start again. Repeat this procedure as many as four times, if necessary. 3. If error still persists, write a tape mark, rewind, and reload new tape. 4. If error still persists, notify remote terminal operator of delay and call IBM customer engineer.
Audible alarm Record light	Lost or duplicated record	1. Push the WTM key one or more times, if desired. 2. Push the subsitute-record switch to ON and then continue normal transmission.
Audible alarm Output light	Machine Error	1. Push the start key. 2. If error persists, call the IBM customer engineer.
Audible alarm	1. Accidental switching of the Rec-Trans switch, or 2. Tape unit door open, or 3. M/D not ready, or 4. Not in character phase.	1. Turn Rec-Trans switch to REC. 2. Close the door. 3. Turn alternate switch to DATA. 4. Check that remote terminal is properly preset.

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IBM

International Business Machines Corporation
Data Processing Division
112 East Post Road, White Plains, New York

7702 MAGNETIC TAPE TRANSMISSION TERMINAL

FEATURES

THE IBM 7702 Magnetic Tape Transmission Terminal, another TELE-PROCESSING* unit, performs all of the functions of the IBM 7701; however, it differs from the 7701 in speed characteristics. The 7702 operates at three standard speeds--150, 250, and 300 characters per second. It transmits over either message service (dial) or private (leased) lines. Like the 7701, the 7702 transmits records of any length; checks reading, writing, and transmission to insure accuracy; automatically retransmits any record that causes an error; writes and reads at a density of 200 characters per inch in either binary or BCD mode. The appearance of the 7702 (Figure 1) is similar, but not identical, to that of the 7701.

* Trademark

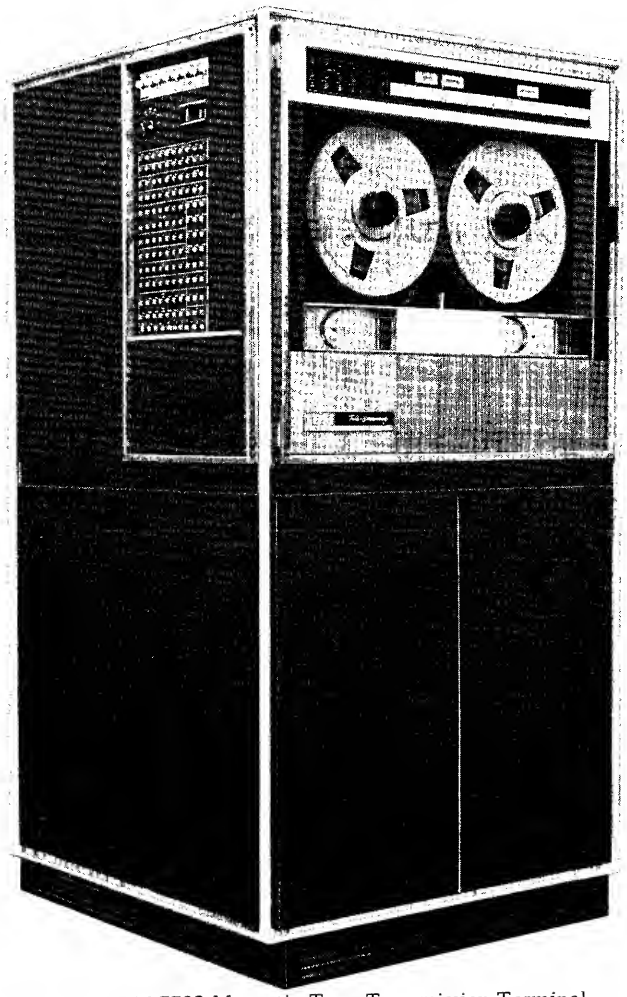

Figure 1. IBM 7702 Magnetic Tape Transmission Terminal

OPERATION

To the operator, the only important differences between the 7701 and the new 7702 are: (1) the presence of the 250- and 300-characters-per-second positions on the speed-selector switch, and (2) the absence of the 75 characters-per-second speed. From the programming standpoint, the 7702 is exactly the same as the 7701.

The internal operation of the 7702 differs from that of the 7701 mainly in one respect: the tape unit is a variable-speed type, rather than incremental type. Whereas the incremental tape unit must come to a complete halt between characters, the variable-speed unit continues without halting between characters until it receives a signal to halt. Like the incremental tape unit, it has the ability to read or write while tape is stationary, or it can operate while tape is moving past the read-write head.

This varying-speed operation of the 7702 gives it superior adaptability and timing efficiency for data transmission.

COMPONENTS

The 7702 unit comprises three components--the synchronous transmitter-receiver (STR), the variable-speed magnetic tape unit, and the variable-speed magnetic tape unit adapter.

To permit reading and writing at varying speeds, the tape unit motor is especially adapted to quick stopping and starting, an optical pulse generator synchronizes the tape with machine operations, and an eight-character register stores characters that are in transit between the read-write head and the STR.

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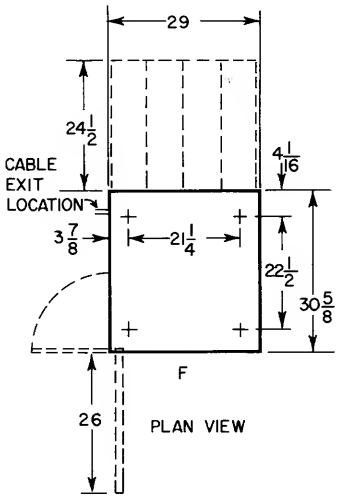
7702 MAGNETIC TAPE TRANSMISSION TERMINAL

PHYSICAL PLANNING INSTALLATION SPECIFICATIONS (TENTATIVE)



Power Requirements: 115 volts plus or minus 10%, 60 cycles plus or minus 1 cycle per second, 15 ampere, single phase.

Power Cord: Approximately 7 feet long with a Pass and Seymour plug number 5267 or equivalent (IBM Plug No. 256341).

Power Consumption:

Volts	Amps.	KW	BTU/hr
115	11	1.07	3,650

Signal Cable: 7702 to sub-set (maximum length 20 feet)

Dimensions (inches); Length - 30-5/8
Width - 29
Height - 61

Weight (lbs): Approximately 950

Service Clearances (inches):

Front	Rear	R.S.	L.S.
42	42	36	36

Temperature and Humidity Requirements (operating):
Temperature - 50-90°F
Relative Humidity - 20-80%

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729 V AND 729 VI MAGNETIC TAPE UNITS BULLETIN

THE IBM 729 V and 729 VI Magnetic Tape Units operate at an increased character density of 800 characters per inch in addition to present character densities of 200 and 556 characters per inch. This means that each 729 V and 729 VI tape unit is able to write or read at 200 or 556, 200 or 800, or 556 or 800 characters per inch. The maximum character rate is thereby increased to 60,000 characters per second on the 729 V and 90,000 characters per second on the 729 VI.

Characteristics of the tape units at all densities are shown in Figure 1.

The 729 V and 729 VI tape units are identical to the 729 II and 729 IV tape units, except for recording characters at 800 per inch.

The pair of recording densities at which a given tape unit operates is controlled by a Tape Densities Option Switch for each tape channel used with magnetic tape. Program instructions or the change-density switch on the tape unit itself specify either high or low density recording. With the switch in position 1, tape units (both 729 V and 729 VI) attached to that tape channel operate in a density of either 200 or 556 characters per inch. With the switch in position 2, the recording density is 200 or 800 characters per inch; in position 3, the density is 556 or 800 characters per inch.

Characteristic	729 V			729 VI		
Tape Speed-- (inches per second)	75			112.5		
Record Density-- (characters per inch)	200	556	800	200	556	800
Maximum Data Rate-- (characters per second)	15,000	41,667	60,000	22,500	62,500	90,000
Character Time-- (microseconds per character)	67	24	17	44	16	11
Average Access Time-- (milliseconds)	10.8			7.3		

Figure 1. Magnetic Tape Unit Characteristics

The following table shows the location of the tape densities option switches and the tape control device used with each data processing system.

System	Switch Location	Tape Control
1401	1401 Processing Unit	800 CPI Feature
1410	1415 Console	800 CPI Feature on 1414 I-O Synchronizer, Model 1
7070-7074	7604 Tape Control, Model 3 (2 channels)	
7080	7621 Tape Control, Model 4 (2 channels)	
7090	7607 Data Channel, Model 3 or 4 (1 channel)	

The 729 VI Tape Unit cannot be used at 800 characters per inch on 1401 or 1410 systems. Figure 2 shows all possible switch settings, together with resultant character rates in characters per second.

Tape Densities Option Switch	729 V Density Mode		729 VI Density Mode	
	Low	High	Low	High
1. 200/556	15,000	41,667	22,500	62,500
2. 200/800	15,000	60,000	22,500	90,000
3. 556/800	41,667	60,000	62,500	90,000

Figure 2. Density Switch Positions

Recording densities on the 729 V are compatible with those on the 729 VI tape unit. That is, a tape recorded at 800 characters per inch on a 729 VI may be read on the 729 V if the 729 V is reading at 800 characters per inch. All other normal programming techniques apply with the increased recording density. For example, execution of a set density low instruction refers to the lower density specified by the density switch on the tape control device. A time comparison, shown in seconds, for 100 records of various character lengths is shown in Figure 3.

Characters Per Record	Recording Densities with the 729 V		
	200 CPI	556 CPI	800 CPI
360	3.49	1.94	1.47
720	5.90	2.81	1.87
1800	13.14	5.40	3.06
3600	25.20	9.72	5.04
	Recording Densities with the 729 VI		
360	2.31	1.30	1.12
720	3.90	1.88	1.52
1800	8.65	3.61	2.71
3600	16.57	6.49	4.69

Figure 3. Time Comparison for 100 Record Blocks (in Seconds)

Figure 4 shows a comparison of capacity for records on a single reel, using both the 729 V and 729 VI at all recording densities.

Characters Per Record	Recording Densities		
	200 CPI	556 CPI	800 CPI
360	11,152	20,343	23,700
720	6,514	13,900	17,236
1800	2,916	7,127	9,480
3600	1,516	3,933	5,417

Figure 4. Single Tape Reel Capacities for All Recording Densities

PROGRAM TIMING IMPROVEMENTS

Phase 1 of a sort application is process-limited for many sorts at 800 characters per inch recording density. Phases 2 and 3, however, generally remain tape-limited on the IBM 7074, 7080, and 7090 Data Processing Systems. For blocked 80-100 character records, a reduction of 25 per cent in sorting times may be achieved when using the 800 character per inch recording mode on 729 VI tape units.

The use of the increased character rate also increases the maximum sort capacity of all sorts. This increase is usually in the range of 30-40 per cent.

When the higher recording densities are used for compiling, savings of 5 to 10 per cent may be realized, depending on the type and size of the program being assembled.

Effective data rates, calculated at various record lengths, are shown in Figure 5. The total job time improvement depends on the tape-limited nature of the work load at any given system installation. An actual billing application involving sorting, file maintenance, and editing shows an anticipated improvement factor of approximately 15 per cent.

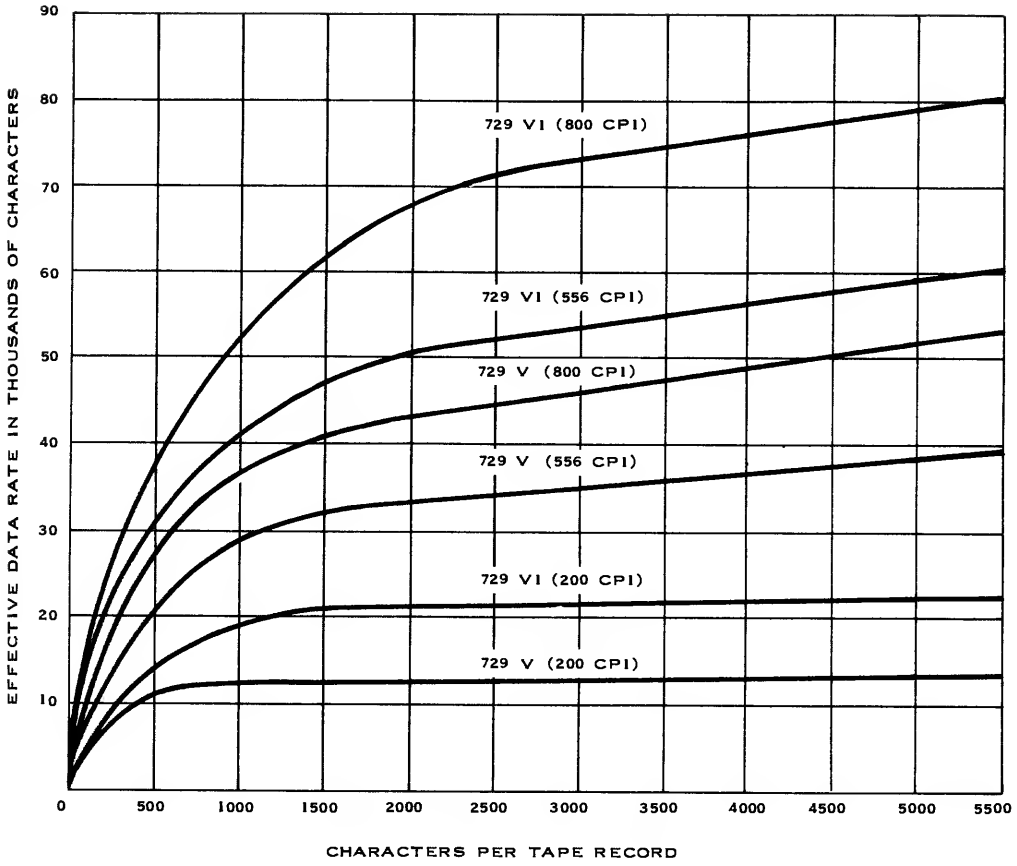

Figure 5. Effective Character Rates

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